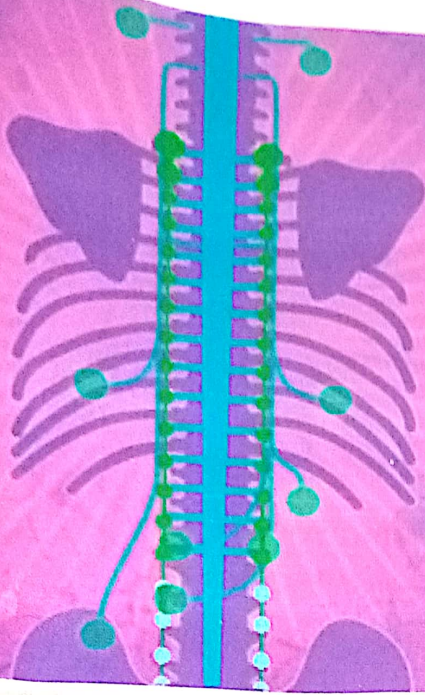




AUTONOMIC NERVOUS SYSTEM

13 INTRO TO THE ANS

~~Dr Nageeb~~ ~~the teacher who make physiology~~ ~~boring are criminals~~

Dr Nageeb

the teacher who make physiology
boring are criminals





Introduction

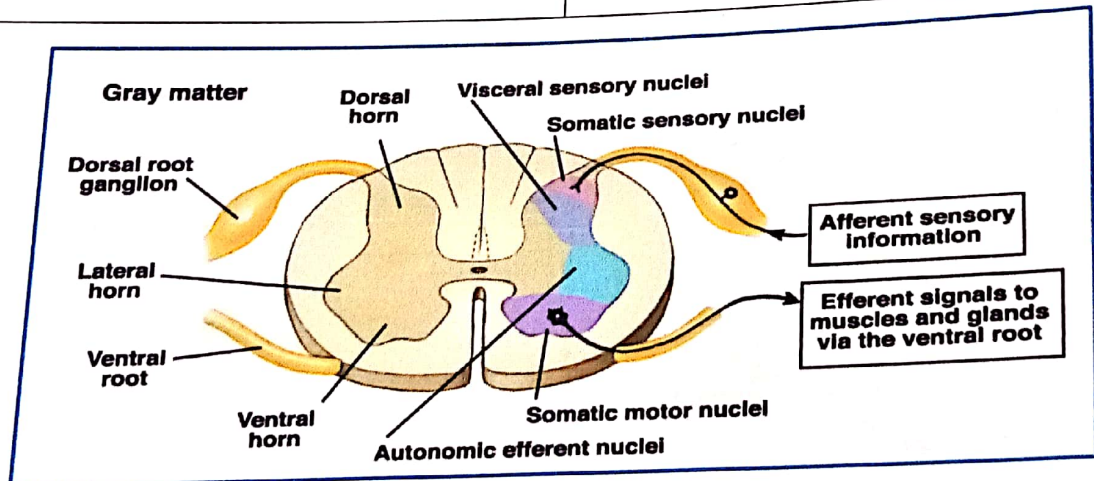
Regulation of body functions:

Nervous regulation
By the nervous system.
Rapid effect for short duration.

Chemical regulation
By hormones, enzymes
Slow effect for long duration.

Divisions of nervous system:

Central nervous system (CNS)	Peripheral nervous system (PNS):
Centrally located and protected by bone	Raised from CNS 12 pairs of Cranial nerves 31 pairs of Spinal nerves
a) Brain, formed of: 1. Cerebral cortex. 2. Brain stem ويتكون من 3 اجزاء → (midbrain & pons & medulla oblongata). 3. Cerebellum. b) Spinal cord, formed of 31 segments: 8 Cervical (C) 12 Thoracic (T) 5 Lumbar (L) 5 Sacral (S) 1 Coccygeal.	a) The somatic nervous system: voluntary. b) The autonomic nervous system: involuntary. c) The "Enteric nervous system": It regulates the activities of the gastrointestinal tract (GIT). It is situated in the wall of GIT. It consists of Meissner's (Submucosal) plexus: → control Secretory activities. Auerbach's (Myenteric) plexus: → control Motor activities.

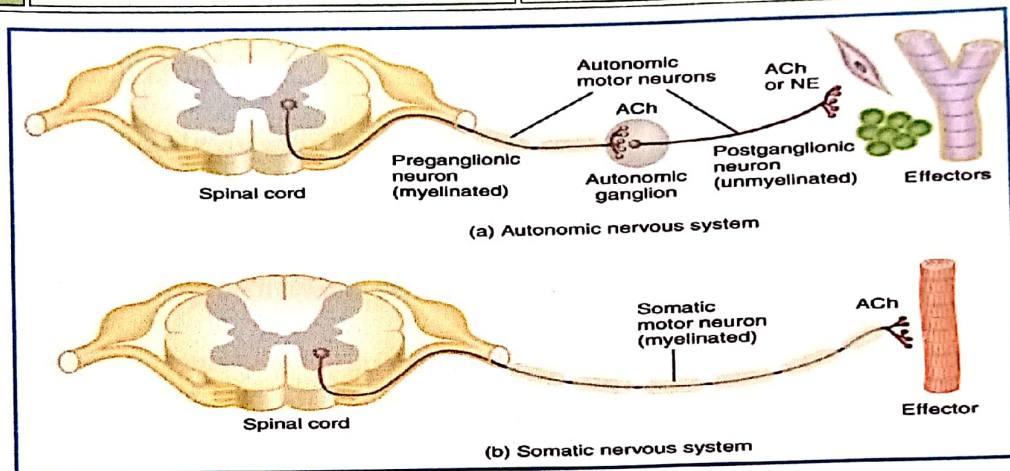


Smile and the whole world smile with you ☺



Difference between autonomic & somatic:

	Somatic nerves	Autonomic nerves
Function	Control voluntary or skeletal muscles.	Control involuntary organs.
Cell body In spinal cord	Present in anterior horn cells. (AHCs)	Present in lateral horn cells. (LHCs)
Axon	Reach the muscle directly . Composed of 1 efferent neuron.	Reach the organs via ganglia . Composed of 2 efferent neurons. (pre ganglionic & post ganglionic)
Impulses	Always carry excitatory impulses.	Carry excitatory or inhibitory impulses.

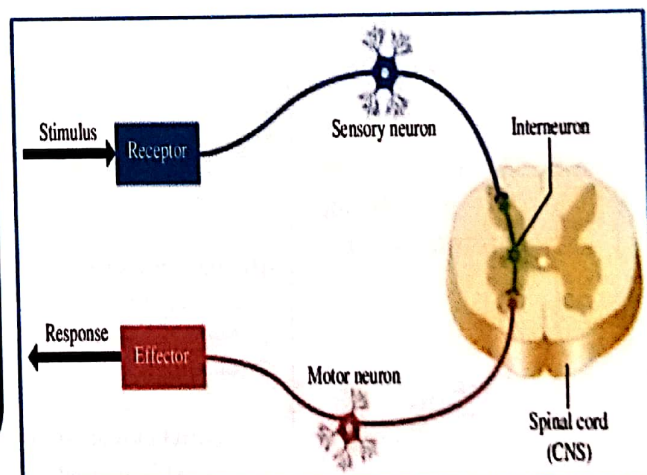


The autonomic nervous system includes two types of fibers:

- Afferent fibers:** which carry **sensations** from visceral organs **to the CNS**.
- Efferent fibers:** which arise **from CNS** to carry **orders** to visceral organs.

The reflex action is the physiological unit of nervous system. It's formed of "reflex Arc"

- 1- Sensory receptor
- 2- Afferent nerve
- 3- Center
- 4- Efferent nerve
- 5- Motor receptor
- 6- Effector Organ





Autonomic ganglia

Definition of autonomic ganglia:

- Ganglion is a Collection of nerve Cells outside the CNS surrounded by Connective tissue Capsule.
- It's the site At which transmission between neuron occurs Chemically by (ACh).
- It Contains: 1- The nerve fiber (axon) of the pre-ganglionic neurons.
2- The cell body (soma) of the post-ganglionic neurons.

	Pre-ganglionic fiber	Post-ganglionic fiber
Cell body	In spinal cord or brain stem.	In autonomic ganglia.
Axon	From CNS to ganglia.	From ganglia to organs.
Type	Myelinated	Unmyelinated

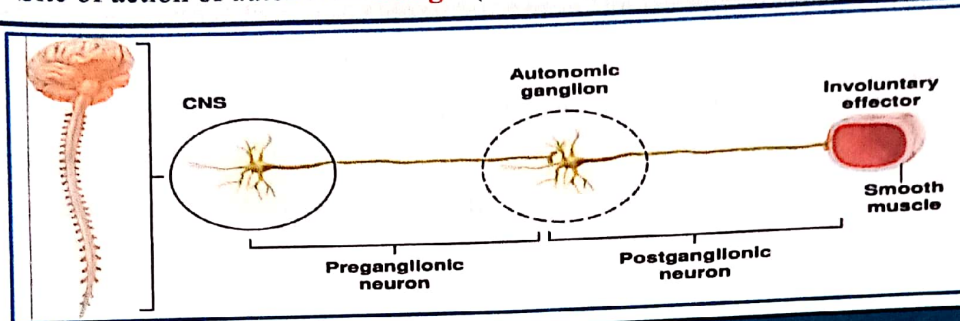
Types of autonomic ganglia:

	1) Lateral Paravertebral	2) Collateral Prevertebral	3) Terminal Peripheral
Site	➤ Present on both sides of vertebral column. ➤ Form sympathetic chain which is formed of 23 ganglia connected with each other ➤ Each chain is composed of: - 3 Cervical (superior & middle & inferior) - 12 Thoracic - 4 Lumbar - 4 Sacral. - 1 coccygeal ganglia " Impar " ➤ Sometimes, inferior cervical ganglion fuses with upper thoracic to form the (stellate ganglion).	➤ Midway between CNS & organs.	➤ Present near the wall or in the wall of the organs.
Type	➤ All lateral ganglia are sympathetic.	➤ Sympathetic: 1) Celiac. 2) Renal. 3) Superior mesenteric. 4) Inferior mesenteric. ➤ Parasympathetic: 1) Otic. 2) Ciliary. 3) Sphenopalatine. 4) Submandibular.	All terminal ganglia are parasympathetic.
Pre-gang	➤ Short fibers.		➤ Long fibers.
Post-gang	➤ Long fibers.		➤ Short fibers.



Functions of autonomic ganglia:

1. **Relay** station for the pre-ganglionic fibers.
2. **Distribution** center. As the ratio of pre-ganglionic to post-ganglionic fibers is (1:8). In this way, pre-ganglionic impulses are expanded into several post-ganglionic neurons.
3. Site of action of autonomic **Drugs**. (see later).



sympathetic nervous system

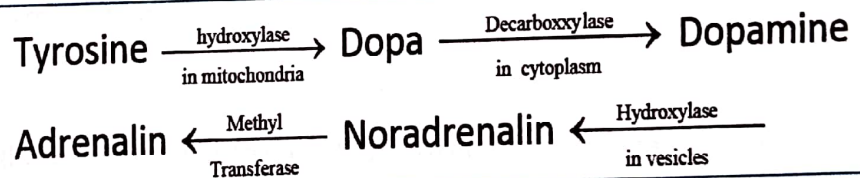
Catecholamines

Synthesis:

- The formation starts at the cytoplasm of the nerve fiber and is completed inside the synaptic vesicles

Storage:

- a) Free:
- b) Cytoplasmic:
- c) Vesicular:



Sites of release of catecholamines:

- 1) At all adrenergic nerve fibers (mainly noradrenaline). i.e. **Sympathetic postganglionic** except: Sweat glands & blood vessels of Skeletal muscle.
- 2) **adrenal medulla**. (adrenaline 80% & noradrenaline 20%).
 - It is called modified sympathetic ganglion.
 - In the suprarenal medulla, the release of catecholamine is mediated by the action of **Ach** which is released from the preganglionic sympathetic fibers.
- 3) Dopamine is released in some areas in the **brain**. (as in **basal ganglia**).



Inactivation of catecholamines:

1. **Active re-uptake: (about 85%).**
 - a) **Neural:** into neural cytoplasm.
 - b) **Granular:** into storage vesicles.
 - c) **Non-neural:** into glial cells & muscles.
2. **Methylation:** by catechol-ortho-methyl-transferase (**COMT**).
This enzyme is found in liver and kidney but **not** in the nerve endings.
3. **Oxidation:** by mono-amino-oxidase (**MAO**).
This enzyme is found in liver, kidney, and in the nerve endings.
4. **Excreted in urine:**
Small amount (in the form of mandilic acid).

للفهم .. امثله على الأعضاء التي يغذيها الجهاز العصبي اللاإرادي

a) Heart → Cardiac properties include:

- 1) Automaticity " قدره القلب على إنشاء كهربته بنفسه "
- 2) rhythmicity. " قدره القلب على النبض بشكل منتظم "
- 3) Conductivity على توصيل الكهرباء لجميع خلاياه
- 4) Excitability. قدره خلايا القلب على الإستجابة للمحفز.
- 5) Contractility. قدره خلايا القلب على ضخ الدم

b) Smooth muscle:

- 1) Blood vessels: especially the arterioles, which control arterial blood pressure (A.B.P.).
- 2) Bronchi مجري التنفس
- 3) GIT : الجهاز الهضمي both in the wall and sphincter.
- 4) Urinary bladder المثانة البولية both in the wall and sphincter.
- 5) The uterus الرحم
- 6) The male sex organs
- 7) The intra-ocular muscles:
 - dilator pupillae muscle (DPM) عضله توسع بؤبؤ العين
 - constrictor pupillae muscle (CPM), عضله تضيق بؤبؤ العين
 - ciliary muscle عضله تتحكم في عدسه العين
- 8) Erector pili muscles عضلات تتحكم في الشعر



c) Exocrine glands: غدد

Salivary الغدد اللعاب

lacrimal, الغدد الدمعية

bronchial غدد تفرز مخاط الجهاز التنفسي

gastric and intestinal الخلايا المسؤولة عن افرازات الجهاز الهضمي

sweat glands. الغدد المسؤولة عن افراز العرق

Receptors in A.N.S. للفهم فقط

classified according to the neurotransmitter that stimulates them into

- 1. Cholinergic receptors (stimulated by acetylcholine) → classified into**
 - Muscarinic (M) → are further subdivided into M1, M2, M3, M4, and M5
 - Nicotinic (N) → are subdivided into Nn and Nm
- 2. Adrenergic receptors (stimulated by noradrenaline) → classified into**
 - Alpha (α) → are subdivided into α_1 and α_2
 - Beta (β) → subdivided into β_1 , β_2 , and β_3

G-protein Receptor → للفهم فقط

Gs	Gi	Gq
↑ Adenyl cyclase → ↑ cAMP inside the cells	↓ Adenyl cyclase → ↓ cAMP inside the cells	Gq → ↑ Phospholipase C → ↑ Ca inside the cells
heart → Stimulatory	heart → inhibitory	heart → Stimulatory
smooth muscle → relaxation	smooth muscle → relaxation	smooth muscle → contraction
Glands → ↑ Secretion	Glands → ↓↓ Secretion	Glands → ↑ Secretion
All beta receptors β_1 - β_2 - β_3	1- α_2 -receptors 2- M2	1- α_1 -receptors 2- M1- M3 – muscarinic

If you can't explain it simply .. you don't understand it enough ☺



Adrenergic receptors

1. Alpha (α) receptors: ($\alpha 1$ & $\alpha 2$). 2. Beta (β) receptors: ($\beta 1$ & $\beta 2$ & $\beta 3$).

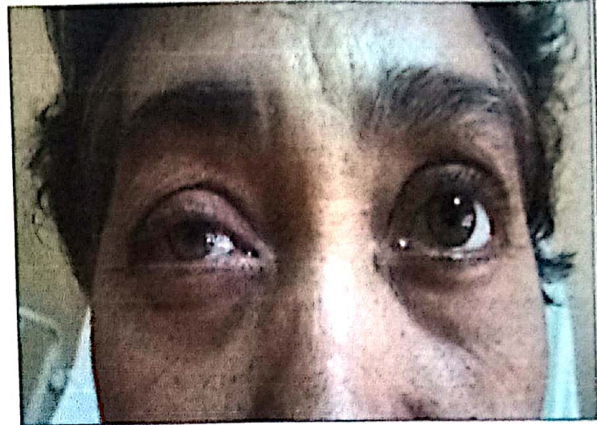
Alpha-1	Alpha-2	Beta-1	Beta-2
Present in: 1. smooth muscles 2. Heart.	1) Postsynaptic receptors: Stimulation of them cause: - Inhibition of lipolysis. - Inhibition of insulin secretion. - Platelets aggregation.	Present in: 1. Heart. 2. Kidney. 3. Fat cells.	Present in: 1. Bronchi. 2. Uterus. 3. Urinary bladder. 4. Myocardium. 5. Other sites.
Stimulation of them causes: 1. VC of blood vessels all over the body. 2. Contraction of smooth muscles as: - Sphincters of GIT. - Spleen capsule. - Smooth muscles of vas deference & seminal vesicles. 3. Mydriasis. إلتساع بؤبؤ العين dilator pupillae muscle (DPM) 4. Cardiac stimulation.	2) Presynaptic receptors: Stimulation of them cause: - Inhibition of further release of chemical transmitter (negative feedback control). 3) Central receptors: Present in the brain. Stimulation of them cause: - Inhibition of sympathetic (sympatholytic effect) and decrease in blood pressure.	Stimulation of them causes: 1. Increase all cardiac properties. 2. Increase renin release from kidney. ماده كيميائية تؤدي إلى ارتفاع ضغط الدم 3. Lipolysis in the fat cells.	Stimulation of them causes: 1. Relaxation of the bronchi. (bronchodilatation) 2. Relaxation of uterine smooth muscles. 3. Relaxation of bladder smooth muscles. 4. Inhibition of platelets aggregation. 5. Stimulate insulin secretion. 6. Glycogenolysis in the liver.
Nor adrenalin > adrenalin	Nor adrenalin > adrenalin	Adrenalin > Noradrenalin	Adrenalin > Nor adrenalin

- **Beta-3** adrenoceptors cause **lipolysis**.



Horner's syndrome:

- **Due to:** damage of superior **cervical** sympathetic ganglion.
- **Caused by:** either experimentally or by disease.
- **Symptoms:** all occur on **same side**:
 - 1) **Ptosis:** drop of upper eye lid.
Due to paralysis of superior tarsal muscle.
 - 2) **Miosis:** pupillo constriction.
Due to paralysis of the dilator pupillae muscle.
 - 3) **Enophthalmos:** inward sinking of the eyeball.
Due to paralysis of Muller's muscle
 - 4) **Anhydrosis:** dryness of the skin.
Due to absence of sweat secretion.
 - 5) **Vasodilatation:**
so appearing more red than the normal side.
Due to the absence of the sympathetic VC tone to the skin vessels.



General functions of sympathetic

A. During rest:

- It causes **sympathetic tone** on the **blood vessels** leading to continuous mild vasoconstriction to maintain the blood pressure.
- Also the heart has weak sympathetic tone.

B. In emergency conditions (The Alarm or Stress response):

- In cases of Fight, Flight, Exercise or Emotions.
- **Alarm or stress response** helps the person for better performance in emergency.
 1. Acceleration of the **heart** to supply blood to active tissues.
 2. **Vasoconstriction** in the inactive regions e.g. skin and splanchnic area to shift more blood to active regions e.g. muscles, heart and brain.
 3. Dilation of **bronchi** to increase pulmonary ventilation.
 4. Contraction of **spleen** capsule to give 250 ml of RBCs to circulation.
 5. Inhibition of **GIT** activities, **defecation**, **micturition** and **erection**.
 - All these factors lead to shift of blood from inactive areas as the gastrointestinal tract to active contracting muscles and to heart.
 6. **Glycogenolysis** to supply glucose to active tissues for energy. Also, **lipolysis**.
 7. **Sweat secretion:** to get rid of the excess heat by evaporation.
 8. Delay muscle fatigue (**Orbelli phenomenon**).
 9. Increase **field of vision**.
 10. **Clotting of the blood** is enhanced for more effective hemostasis.
 11. **Adrenal medulla** is stimulated to secrete adrenaline to aid and intensify all the above reaction



Acetyl choline

Synthesis of Ach:

- Ach is synthesized in cholinergic nerve fiber by acetylation of choline:
- Acetyl CoA + Choline $\xrightarrow[\text{ATP} + \text{glucose}]{\text{Choline Acetyl Transferase}}$ Acetyl choline + CoA.

Sites of release of Ach: (cholinergic fibers):

- 1) At all autonomic **ganglia** (from all preganglionic nerve endings).
- 2) At the **suprarenal medulla** (from preganglionic fibers to suprarenal medulla).
- 3) At all **motor end plates** (from all somatic nerves supplying skeletal muscle).
- 4) Inside the **CNS**.
- 5) At all **Parasympathetic Postganglionic** nerve fibers.
- 6) At Some Sympathetic postganglionic nerve fibers to:
Sweat glands & blood vessels of Skeletal muscle.

Inactivation of Ach:

1. Ach is rapidly hydrolyzed by the **cholinesterase enzyme**.

- Ach is hydrolyzed into → choline base and acetate.
- There are two types of cholinesterase enzyme:

True or specific cholinesterase	Pseudo cholinesterase
- Presents in Terminals of cholinergic fibers. - Other sites: Red blood cells & nervous tissues. - Specific for Ach only. - Slow turnover. - Takes 120 days to regenerate again. - Prevents prolonged fatal effect of Ach like: Bronchospasm & inhibition of heart. - So, it is essential for life.	- Presents in Plasma - Other sites: Liver & intestine & CNS. - Nonspecific for many esters. - Rapid turnover. - Easily synthesized in the liver. - Inactivate the small amount of Ach that escape to blood from sites of its release.

2. Diffusion from site of release to the blood or to other sites (small amount).

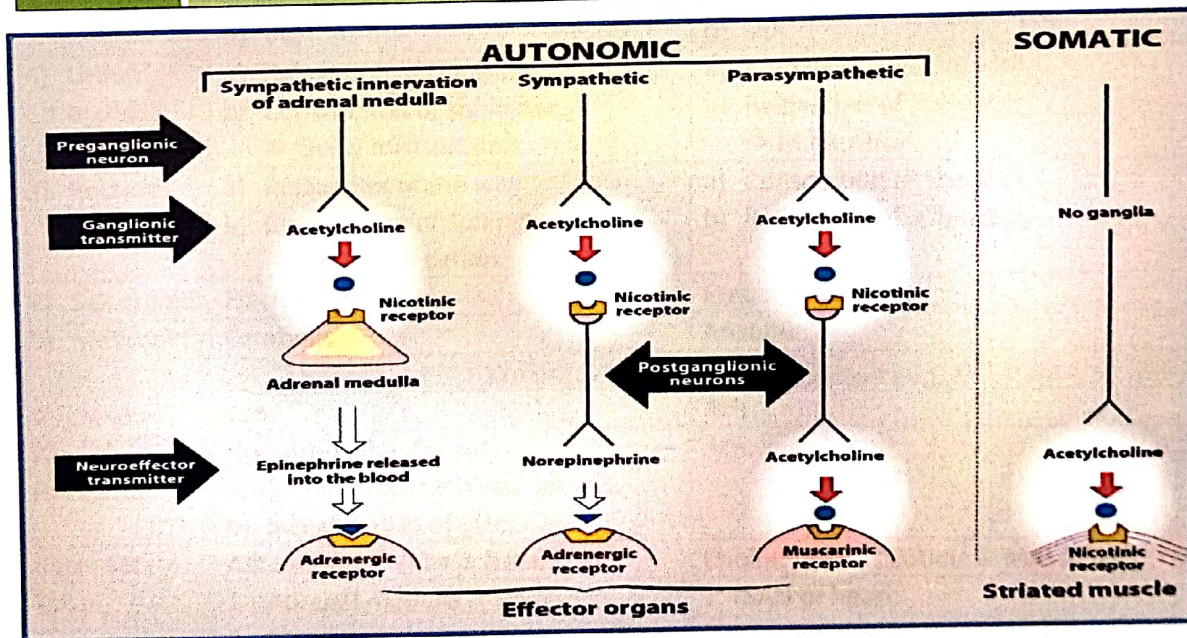
Then, inactivated by pseudo cholinesterase.

3. Active re-uptake by the synaptic vesicles. (for choline only).



Cholinergic receptors:

	Nicotinic receptors	Muscarinic receptors
Sites	- At all autonomic ganglia. - At the supra renal medulla. - At all motor end plates. - Inside the CNS.	- In the effector organs of all parasympathetic postganglionic: Cardiovascular system (atrium). CNS. Respiratory system. Eye. Exocrine glands. GIT. Genitourinary system. - In the effector organs of Some Sympathetic postganglionic: Sweat glands. Blood vessels of Skeletal muscle.
Stimulant	Small dose of nicotine.	Muscarine.
Blocker	Large dose of nicotine.	Atropine or hyosine.
Actions	Rapid action but for short duration.	Slow action but for long duration.
Types	(Nn) at nerve endings (ganglia). (Nm) at motor end plate.	5 Subtypes: (M1 & M2 & M3 & M4 & M5).
Mechanism of Action	All are (Excitatory). Act by $\uparrow$ Na^+ influx $\Rightarrow$ depolarization.	- M1 & M3 & M5 (Excitatory). Act by $\uparrow$ Ca^{++} release. - M2 & M4 (Inhibitory). Act by $\downarrow$ c AMP.



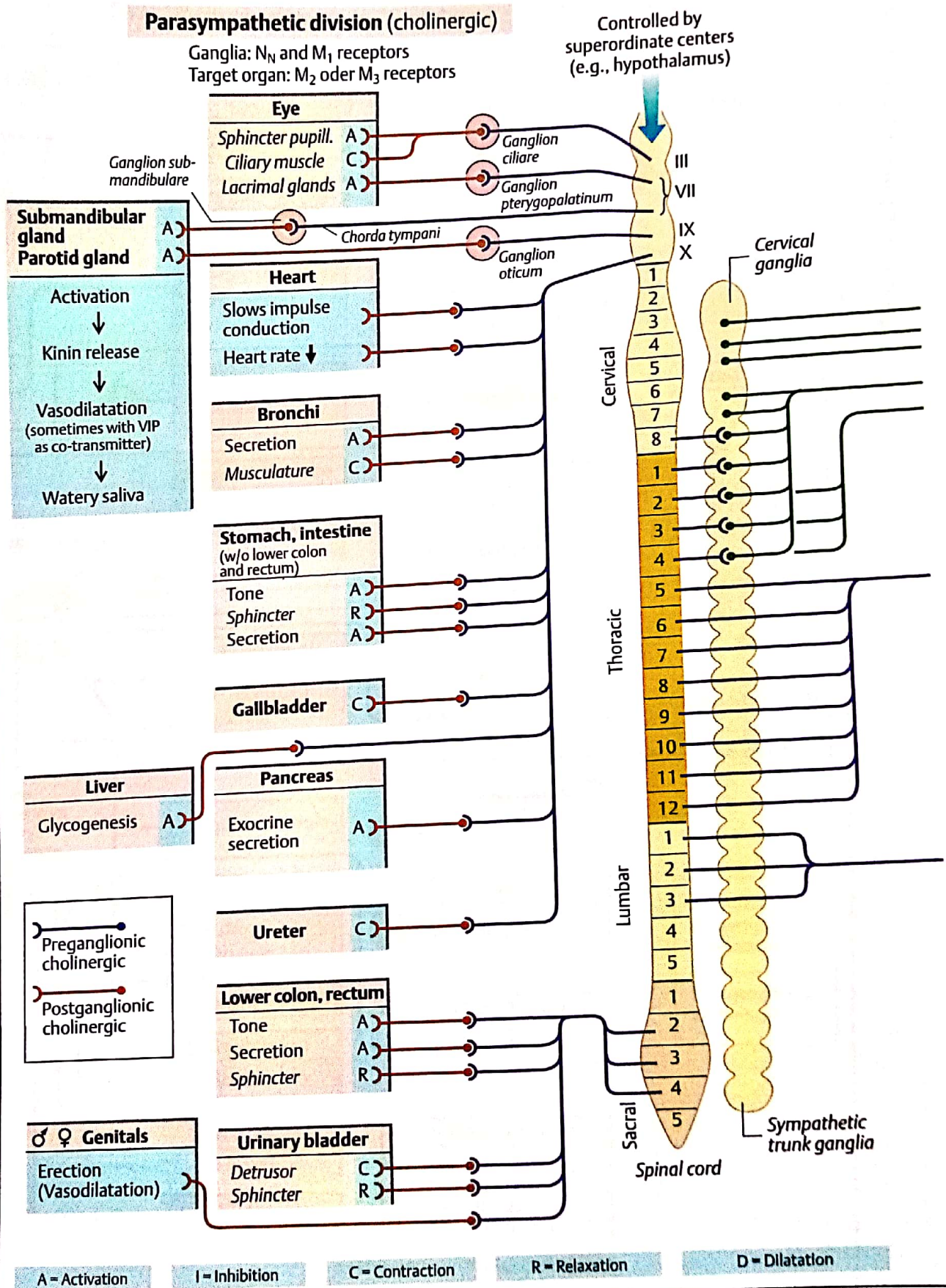
"لا يعرض عنك صادق في وده , إنما يهجر من كان وده مكتوباً."

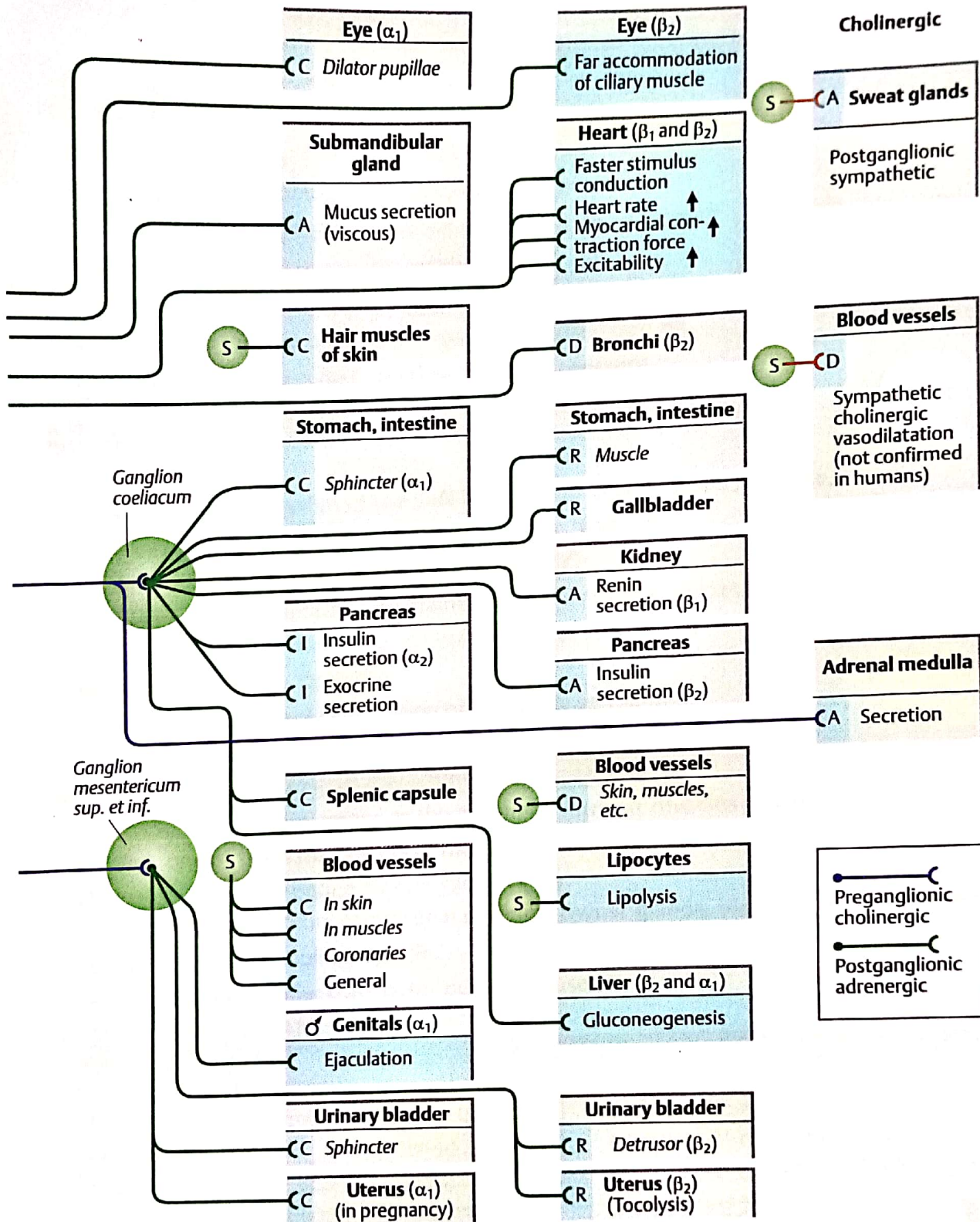


Divisions of ANS

Origin	Sympathetic	Parasympathetic
	LHCs of 1- all thoracic segments 2- upper 2 lumbar Thoraco-lumbar outflow.	- Some cranial nerves. (III & VII & IX & X). - LHCs of 2nd, 3rd & 4th sacral segments of the spinal cord. Cranio-sacral outflow.
Ganglia	All lateral + 4 collateral.	All terminal + 4 collateral.
Preganglionic	Short. (secrete Ach).	Long. (secrete Ach).
Postganglionic	Long. (secrete NE, except SS).	Short. (secrete Ach).
Action	During stress (Generalized).	During rest (Localized).
Effects		
1) Eye	a) Mydriasis. → b) Far vision.	a) Miosis. b) Near vision.
2) Salivary	Trophic secretion. (little amount & viscid).	True secretion. (large amount & watery).
3) Heart	c) ↑ All properties. d) Indirect coronary VD.	a) ↓ Properties. (in <u>atria only</u>). b) Indirect coronary VC.
4) Lung	a) Bronchodilatation. b) VC of pulmonary vessels. c) ↓ Secretion.	a) Bronchoconstriction. b) VD of pulmonary vessels. c) ↑ Secretion.
5) GIT	a) Relaxation of the wall. b) Constriction of sphincters. c) ↓ Secretion. d) VC.	a) Contraction of the wall. b) Relaxation of sphincters. c) ↑ Secretion. d) VD.
6) Urinary Bladder	a) Relaxation of the wall. b) Constriction of sphincter. ⇒ Delay micturition.	a) Contraction of the wall. b) Relaxation of sphincter. ⇒ Micturition.
7) Rectum	a) Relaxation of the wall. b) Constriction of sphincter. ⇒ Delay defecation.	a) Contraction of the wall. b) Relaxation of sphincter. ⇒ Defecation.
8) Sex organs	Ejaculation.	Erection.
9) Metabolic	Catabolic.	Anabolic.
Chemical transmitter		
At ganglia	Ach.	Ach.
At Postganglionic	Noradrenaline. Except: a) <u>S</u> keletal muscle blood vessels. b) <u>S</u> weat glands of <u>S</u> kin.	Ach.
Receptors	Adrenergic: Alpha & Beta.	Cholinergic: Nicotinic & Muscarinic.
Tone	1. Adrenal medulla. 2. Blood vessels.	1. SAN of heart. 2. Gastro Intestinal Tract (GIT). 3. Bronchi.

A. Functions of the autonomic nervous system (ANS)



Sympathetic division(Preganglionic cholinergic: N_N and M_1 receptors, postganglionic mainly adrenergic) α receptors (α_1 : $IP_3 + DAG \uparrow$; α_2 : $cAMP \downarrow$) β receptors ($cAMP \uparrow$)

S = Efferents from affiliated CNS segment



Sympathetic and parasympathetic tones

Definition of autonomic tone:

- It is **continuous** rhythmic nervous discharge from nerve center to certain organ in the body.

Types of autonomic tones:

1. Sympathetic tone

a) Sympathetic tone to the **Adrenal medulla**:

- Maintains basal amount of catecholamine secretion.
- Important for regulation of blood pressure & glucose level.

b) Sympathetic tone to the **Blood vessels**:

- Mild VC $\Rightarrow$ regulates diameter of arterioles.
- This maintains normal blood pressure at 120/80 mm Hg.
- It affects diastolic blood pressure > systolic pressure.

2. Parasympathetic tone (Vagal tone)

a) Vagal tone to the heart (**SAN**):

- Decreases the rhythm of the SAN from 110 to only 70 beats / minute.
- This greatly spares excess energy & effort in the heart.

c) Vagal tone to the gastrointestinal tract (**GIT**):

- Prevents GIT distention and maintain basal amount of secretion.
- This is very important to complete the digestive process.

b) Vagal tone to the **bronchi**:

- Maintains constant distribution of air during ventilation.
- Protects the bronchial wall during cough.

3. Mixed sympathetic and parasympathetic tones

- Presents in certain organs as the heart and intrinsic muscles of eye.
- But, one of them may be **predominant** in relation to the other.

Many organs are supplied by one system only:

- **Sympathetic only**: **S**kin, **S**uprarenal medulla, **S**weat glands, blood vessels of **S**keletal muscle, ventricles, dilator pupillae muscle.
- **Parasympathetic only**: constrictor pupillae muscle.

Mode of action of ANS:

Sympathetic	Parasympathetic
Usually, generalized . But, in certain cases isolated sympathetic discharge as sweat glands & cutaneous vessels in hot weather in order to cool body.	Usually, localized . But, sometimes generalized parasympathetic predominant during sleep or after meals (digestion).



Denervation of organ from autonomic supply

- But, both sympathectomy & vagotomy are associated with many side effects.
- This interruption may be:
 - a) **Medical (temporary)**: by using certain drugs which block the effect of chemical transmitters or block the autonomic receptors.
 - b) **Surgical (permanent)**: in more severe cases, we cut the autonomic supply to certain organs.

Sympathectomy:

- Removal of **S**ympathetic innervation may be done in the following diseases:
 - 1) **Vascular S**pasm: associated with VC in vessels which may lead to gangrene as in Berger's disease.
 - 2) **S**evere pain: which is transmitted by sympathetic afferent as in advanced cancer of the urinary tract and anginal pain.
 - 3) **Excessive S**weating: hyperhydrosis.

Parasympathectomy:

- Specially vagotomy may be done in:
- Removal of **P**arasympathetic innervation (vagotomy) may be done in:
 - 1) **P**eptic ulcer: of stomach or duodenum to decrease gastric acid secretion.



The higher centers of ANS

- ANS is a part of the peripheral nervous system.
- So, it performs its functions under control of higher centers present in the **(CNS)**.

1) The spinal autonomic centers:

- The simplest and the lowermost centers of the ANS.
- Present in the **LHCs** which give the origin of ANS and receive many excitatory or inhibitory impulses from more higher centers.
- The most important spinal autonomic centers are:
 - a) **Spinal vasomotor centers** which regulate diameter of the vessels.
 - b) **Micturition & defecation & erection center.** (LHCs of S 2,3,4).

2) The brain stem autonomic centers:

- They are present in the **brain stem** and control the spinal cord LHCs.
- The most important brain stem autonomic centers are:
 - a) **Cardiac** centers and vasomotor center.
 - b) **Salivary** nuclei & gastric secreting center & vomiting center.

3) The hypothalamic autonomic centers:

- Hypothalamus is the center of **emotions**.
- Hypothalamus regulates **food** intake & **water** balance & body **temperature** & **sleep** & adrenaline secretion.
- There are two groups of nuclei in hypothalamus:
 - a) **Posterior & lateral** nuclei: higher centers of the **sympathetic** all over the body.
 - b) **Anterior** nuclei: higher centers of the **parasympathetic**.

4) The cerebral cortex autonomic centers:

- It is the highest center of the autonomic functions.
 - Present in areas in brain called the **visceral cortex** and the **limbic system**.
 - The cortex can affect other autonomic centers by either:
 - a) **Direct** descending fibers from the cortex to LHCs.
 - b) **Indirect** connections to other centers.
- e.g. From the limbic system to the hypothalamus then finally to LHCs.

الروح إن خلت من المعنى، تكون في الجسد كسيف خشبي في غمده.. وإذا ما استلته صاحبه، لم يصلح لشيء إلا وقوداً للنار. فلا تحمل للميدان سيفاً خشبياً

There are 4 sympathetic divisions according to distribution: (Cervical & Cardio-pulmonary & Splanchnic & Somatic)

4 sympathetic divisions according to distribution: (Cervical & Cardio-pulmonary & Splanchnic & Somatic)					
Supply	Cervical	Cardio-pulmonary	Splanchnic		Somatic
Pre gang (Origin)	Structures in head & neck LHCs of: upper 2 thoracic segments	Structures in the chest LHCs of: upper 4 thoracic segments	A) Abdominal: Structures in abdomen LHCs of: lower 8 thoracic segments Pass without relay in sympathetic chain to form the: Greater splanchnic nerve	B) Pelvic: Structures in pelvis LHCs of: upper 2 lumbar Pass without relay in sympathetic chain to form the: Lesser splanchnic nerve on both sides, unit to form presacral nerve	In upper limb: - Arise from LHCs of 4th to 8th thoracic - Relay in the lower cervical and upper 4 thoracic ganglia. - Postganglionic fibers join the brachial plexus. In lower limb: - Arise from LHCs of 10th thoracic to 2nd lumbar - Relay in lumbar and sacral ganglia. - Postganglionic fibers join the lumbar plexus.
Relay	superior cervical sympathetic ganglion	cervical & upper 4 thoracic ganglia	celiac & renal & superior mesenteric ganglia. (collateral)	inferior mesenteric ganglion. (collateral)	
Post gang	follow the course of carotid arteries	form superficial & deep cardiopulmonary plexuses	supply abdominal organs	supply pelvic organs	
Function	1) Eye: a) Contraction of dilator pupillae muscle $\Rightarrow$ mydriasis (dilatation of pupil). b) Contraction of superior & inferior tarsal muscles $\Rightarrow$ widening of the palpebral fissure. Thus widening the field of vision. c) Contraction of Muller's muscle (retro orbital muscle) $\Rightarrow$ exophthalmos (forward protrusion of eye ball). But, more in animals.	1) The heart: a) Stimulate all properties of the cardiac muscle: Excitability Rhythmicity Conductivity Contractility $\uparrow$ cardiac metabolism & O_2 consumption. c) Coronary vessels: Direct effect: vasoconstriction (via α_1 adrenergic effect). Indirect effect: coronary vessels dilate due to increased metabolism of the heart $\Rightarrow$ decrease O_2 concentration (hypoxia). Metabolites and hypoxia $\Rightarrow$ VD. The indirect effect is predominant $\Rightarrow$ VD & $\uparrow$ coronary blood flow.	1) Gastrointestinal tract (GIT) motility: Relaxation of the wall & constriction of the sphincters. Leading to delayed evacuation. 2) GIT secretions: General inhibition of GIT secretion. 3) The spleen Motor to capsule $\Rightarrow$ push 250 ml of stored RBCs into circulation. (more in animals). 4) The liver: Stimulate metabolism in the form of catabolism : a) Glycogenolysis $\Rightarrow$ increase blood glucose level. b) Lipolysis $\Rightarrow$ increase blood lipid level.	1) The urinary bladder: - Relaxation of the wall (detrusor muscle) & constriction of the sphincter (internal urethral sphincter). - Leading to delayed micturition (retention of urine). - Also, the desire of micturition disappears. - It prevents semen to flow back into the bladder during ejaculation.	A. Fibers going to the Skin supply: a) Sweat glands: 1. Eccrine glands: Copious secretion (Cholinergic fibers). Found in skin all over the body. 2. Apocrine glands: thick secretion with odor. Found in axilla and genital areas. b) Blood vessels $\Rightarrow$ vasoconstriction. c) Erector pilae muscles $\Rightarrow$ erection of hair. More in animals like cats during fighting or cold weather.

d) Relaxation of ciliary muscle ⇒ ↓ power of lens ⇒ prepare the eye for far vision. 2) Glands: a) Lacrimal glands: little secretion of tears and vasoconstriction. b) Salivary glands: trophic secretion and vasoconstriction. (small in amount & viscid & concentrated) 3) Skin: a) Sweat glands ⇒ copious secretion from eccrine glands (cholinergic fibers). b) Blood vessels ⇒ vasoconstriction. c) Erector pilae muscles ⇒ erection of hair. But, more in animals. 4) Cerebral vessels: Mild vasoconstriction. But, during sympathetic stimulation, the cerebral blood flow increase due to the rise in arterial blood pressure.	2) The Lung: a) Bronchi: Bronchodilation. b) Pulmonary vessels: Vasoconstriction. c) Bronchial mucosa: Inhibition of bronchial secretions. These widen the air passages & lead to better ventilation.	5) The splanchnic vessels: Vasoconstrictor (via α-receptors). Vasodilator in some areas as liver (via β-receptors). The effect is mainly VC. 6) The Pancreas: - Inhibition of insulin secretion. - Inhibition of exocrine secretion (digestive enzymes). 7) The kidney: - VC of renal blood vessels ⇒ decrease renal blood flow ⇒ decrease urinary output (via α-receptors). - Stimulation of renin secretion (via β-receptors). 8) The adrenal medulla: - Secretes the catecholamine hormones which are: Adrenalin (80%) Noradrenalin (20%). - Function of released adrenalin: a) Stimulates lipolysis. b) Stimulates thermogenesis. c) Stimulates blood clotting by releasing clotting factors from the liver. d) Stimulates the reticular formation of the brainstem ⇒ increased alertness with lack of sleep (insomnia).	2) The rectum: - Relaxation of the wall & constriction of the sphincter (internal anal sphincter). - Leading to delayed defecation (retention of feces). - Also, the desire of defecation disappears. 3) The sex organs: a) In female: - It is mainly inhibitory on uterus & fallopian tubes. - But, late in pregnancy it is excitatory on the uterus. b) In male: - It is mainly excitatory on smooth muscles of epididymis & vas deferens & seminal vesicles & prostate leading to ejaculation. - VC of blood vessels ⇒ shrinkage.	B. Fibers going to blood vessels of skeletal muscle: Causing vasodilatation (cholinergic effect). This VD ⇒ blood flow & stimulates metabolic processes needed for energy production. (Orbelli phenomenon) During sympathetic stimulation, skeletal muscles show: 1) Increase power of contraction. 2) Delay of fatigue. 3) Early recovery after fatigue. All these effects are due to VD.
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لم يبق في وسعي التحمل اعطاني المستحسن
-عائدي ستمعلمو الانتحل فطير
- اي التحمل ايها الابيه، سوف اقلن الجميع